System Architecture and Design Overview

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Topics

- **Technical Approach**
- **System Overview**
- **IDOT PTC System Architecture**
- **Segment Architecture & Design**
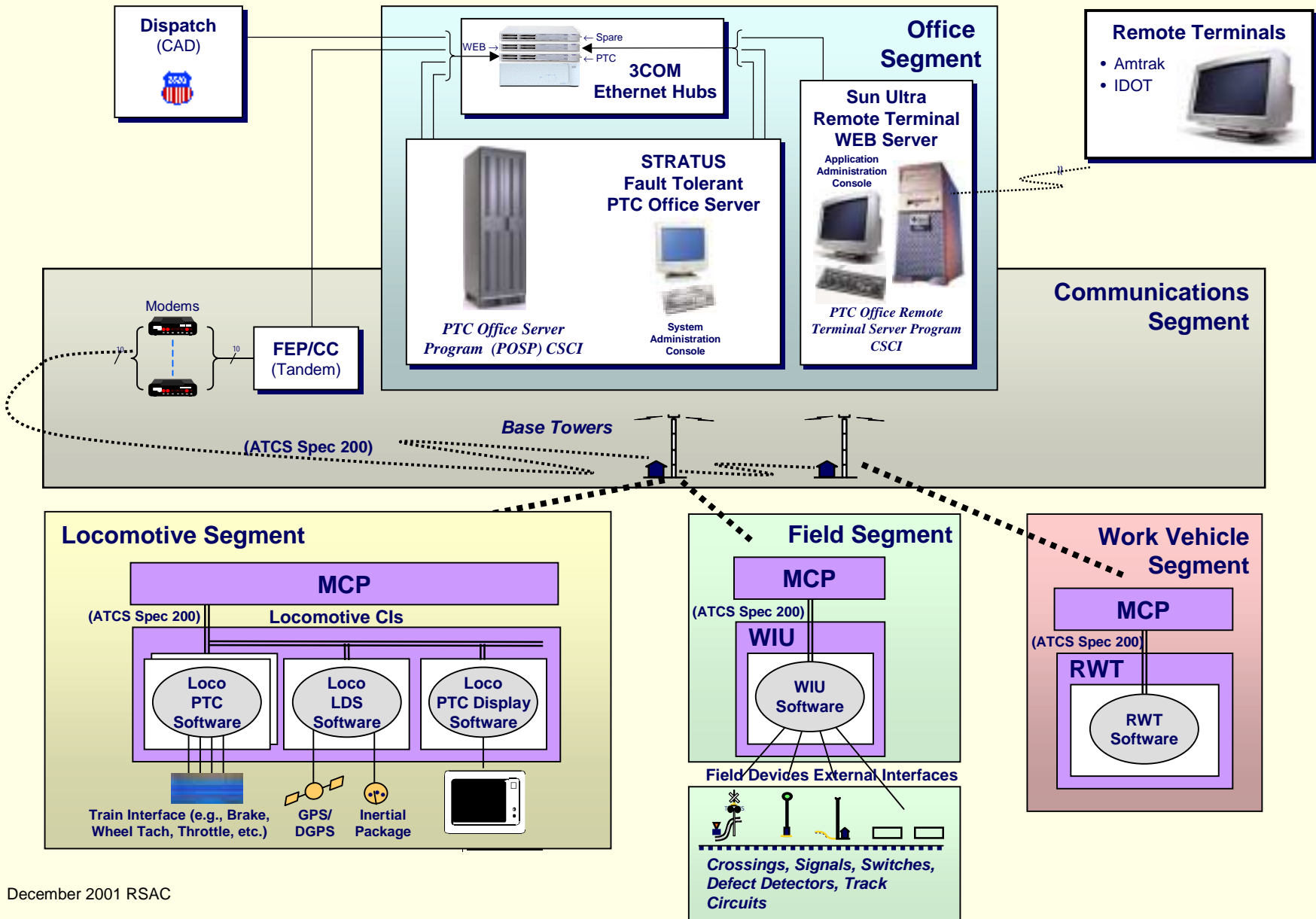- **Summary**

Technical Approach

- **Non-proprietary - open systems architecture**

- **Disciplined systems engineering and integration process**

- **Optimize use of commercial off-the-shelf standards and equipment**

- **Leverage use of/support Rail Industry Standards**

- **Reliable/mature level of software development**

- **Comprehensive system safety program**

System Overview

- **IDOT PTC Project encompasses the design, development, integration and test of an open architecture PTC System meeting SE-provided System Specification requirements:**
    - Four subsystems (segments) provided by Lockheed Martin SDI Team:
        - Office
        - Locomotive
        - Field
        - Work Vehicle
    - Remaining two subsystems integrated with the above and customer-furnished by UPRR
        - Dispatch (CAD)
        - Communications (ATCS Spec 200)

IDOT PTC System Architecture

Dispatch (CAD)

Office Segment

WEB → ← Spare
← PTC

3COM Ethernet Hubs

Remote Terminals
- Amtrak
- IDOT

STRATUS Fault Tolerant PTC Office Server

Sun Ultra Remote Terminal WEB Server

Application Administration Console

PTC Office Server Program (POSP) CSCI

System Administration Console

PTC Office Remote Terminal Server Program CSCI

Communications Segment

Modems

FEP/CC (Tandem)

10

Base Towers

(ATCS Spec 200)

Locomotive Segment

MCP

(ATCS Spec 200)   **Locomotive CIs**

Loco PTC Software

Loco LDS Software

Loco PTC Display Software

Train Interface (e.g., Brake, Wheel Tach, Throttle, etc.)

GPS/ DGPS

Inertial Package

Field Segment

MCP

(ATCS Spec 200)

WIU

WIU Software

Field Devices External Interfaces

Crossings, Signals, Switches, Defect Detectors, Track Circuits

Work Vehicle Segment

MCP

(ATCS Spec 200)

RWT

RWT Software
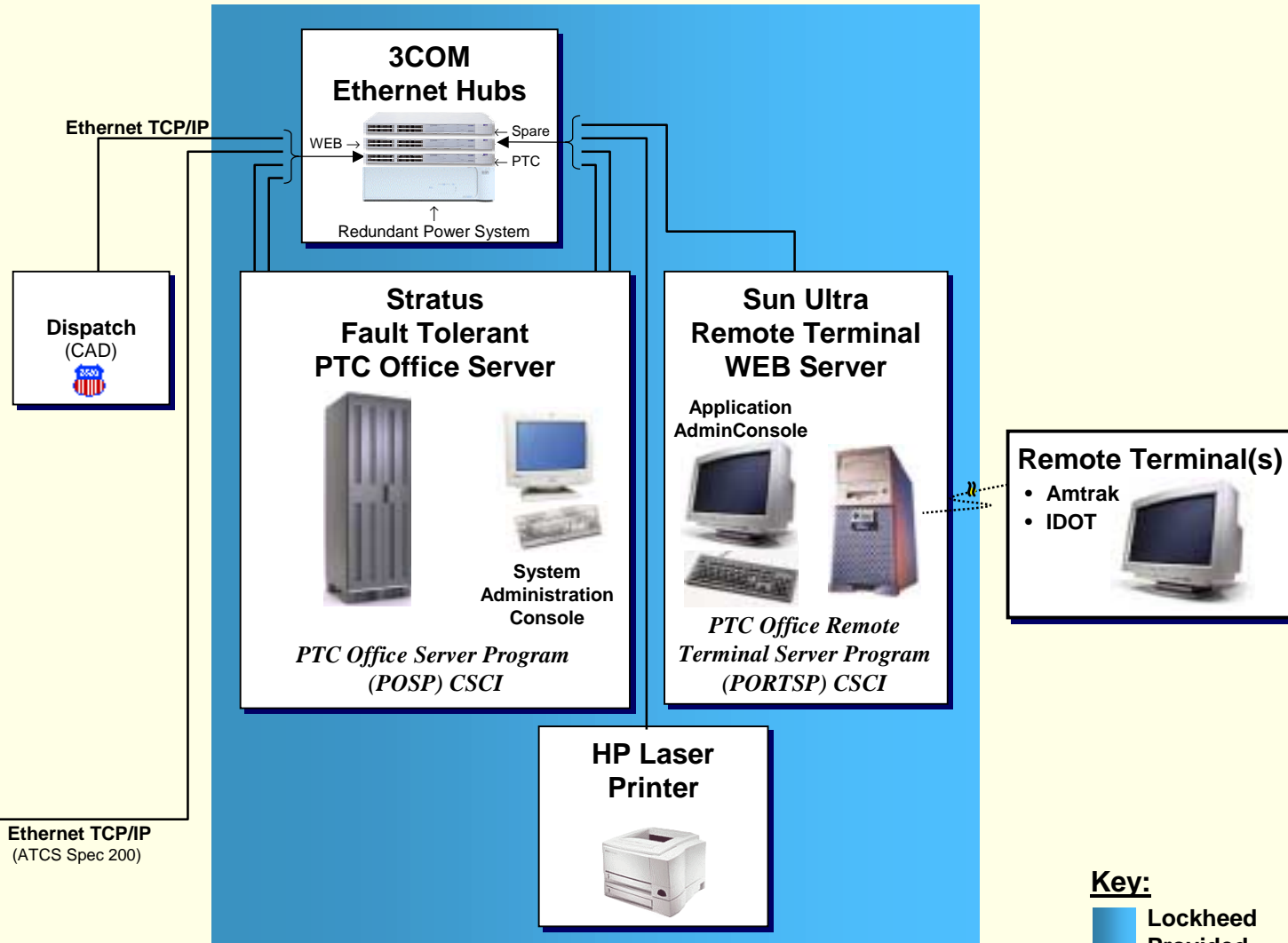
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5

Office Segment

- **Manages overall control of the IDOT PTC System**
- **Uses Commercial-Off-the-Shelf processors and Lockheed-developed rail application software:**
  - PTC Office Server
    - Provides overall control of PTC System and support for system "building block" functions (e.g. authority/speed management)
    - Stratus Continuum HP-PA RISC (Reduced Instruction Set Computer)
  - PTC Office Remote Terminal Server
    - Supports remote train location displays at IDOT and Amtrak authorized sites
    - Sun Ultra architecture

Office Segment (Cont)

HWCI	CSCI
• PTC Office Server (POS)	• PTC Office Server Program (POSP) • Common Object Library (COL)
• PTC Office Remote Terminal Server (PORTS)	• PTC Office Remote Terminal Server Program (PORTSP)
• Ethernet Hubs	• n/a
• Printer	• n/a

3COM Ethernet Hubs

Ethernet TCP/IP

WEB →   ← Spare
← PTC

↑
Redundant Power System

Dispatch
(CAD)

Stratus Fault Tolerant PTC Office Server

System Administration Console

PTC Office Server Program (POSP) CSCI

Sun Ultra Remote Terminal WEB Server

Application AdminConsole

PTC Office Remote Terminal Server Program (PORTSP) CSCI

Remote Terminal(s)
• Amtrak
• IDOT

Modems

FEP/CC
(Tandem)

Ethernet TCP/IP
(ATCS Spec 200)

HP Laser Printer

<u>**Key:**</u>

Lockheed Provided

Locomotive Segment

- **Manages overall locomotive location, speed, braking determination, movement authorities, and display/human machine interface (HMI)**

- **Three main sub-components using Commercial-Off-the-Shelf technologies, processors and Lockheed- and Wabtec-developed application software:**

  - Locomotive Onboard Computer

  - Location Determination System

  - Onboard Display/HMI

Locomotive Segment Architecture

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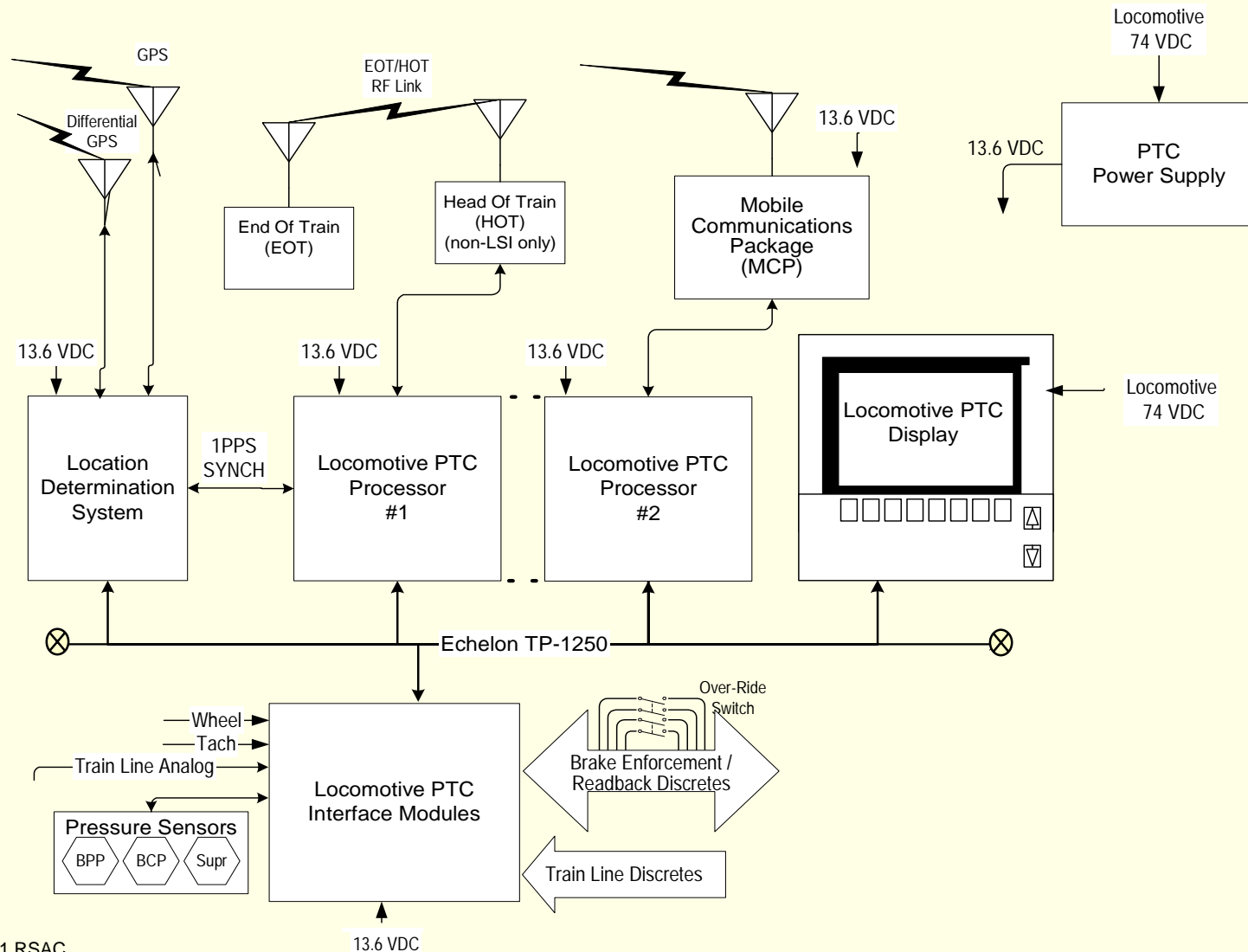
Locomotive Onboard Computer

- **Two Onboard processors (OBC 1,2) provide the central processing for the PTC Locomotive segment**
  - OBC 1 primarily responsible for on board communication processing
  - OBC 2 primarily responsible for Speed/Position prediction, Enforcement functionality and off board communication
- **Interfaces with Train systems and Communication segment**
  - MCP interface for ATCS 200 Base station communication
  - LIMs interface for train system interface

Locomotive Onboard Computer

Key Onboard Computer Components

- **COTS based design with custom package enclosure**

- **133Mhz 586 processor with 32Mb DRAM and 48 Mb Flash Memory**

- **Echelon TP-1250 interface module**

- **RS232/422 asynch/synch serial ports**

- **QNX 6.1 RTOS**

- **Powered From DC-DC Power Supply**

Locomotive Segment –
Location Determination System

- **Same 586 Processor, Echelon TP-1250 Bus Interface Components, and Operating System As On-Board Processor**

- **Separate Enclosure From Other Locomotive Hardware Includes Sealed Sensor Package**

- **High Precision, Multi-sensor, Integrated System Including Gyro and Accelerometers in 3 Axis.**

- **Direct Connections to GPS and DGPS Antennas**

- **Receives Wheel Tachometer Inputs Via Locomotive Interface Module and Echelon Bus**

Locomotive Segment – On-Board Display/HMI

- **Provides primary operator interface for engineer to safely operate PTC equipped locomotive**

- **Provides visual and audio indications of train targets (authorities, speed restrictions, work Limits, etc)**

- **Supplements train control operation by providing engineer with speed, speed prediction, track profile and gradient data**

- **Provides simple control set for operator to enter data and interact with PTC alert indications (e.g. warnings, messages, acknowledgements)**

Locomotive Onboard Display/HMI

Key Display features

- Operator entry via 8 soft keys
- 10" LCD with 640x480 resolution and 256 colors
- Backlit and dimmable via 2 soft keys
- Anti reflective coating

Key Processor Features

- 133Mhz 486 processor with 32Mb RAM and Flash Card
- QNX 6.1 RTOS
- PC104 bus with Echelon TP-1250 Module interface
- RS-232 asynch serial port
- Powered from 74 VDC via PTC breaker
- Audio device interface

Locomotive Segment – On-Board Display/HMI

Field Segment

- **Provides remote control and monitoring of wayside devices through wayside interface units (WIUs):**
  - Control points, intermediate signals, highway crossings, Defect Detectors
- **Uses MicroLok II multi-purpose interlocking control system and US&S developed application software**
- **Interfaces via ATCS Spec 200 MCP with UPRR CAD and PTC Office Server**

Field Segment (Cont)
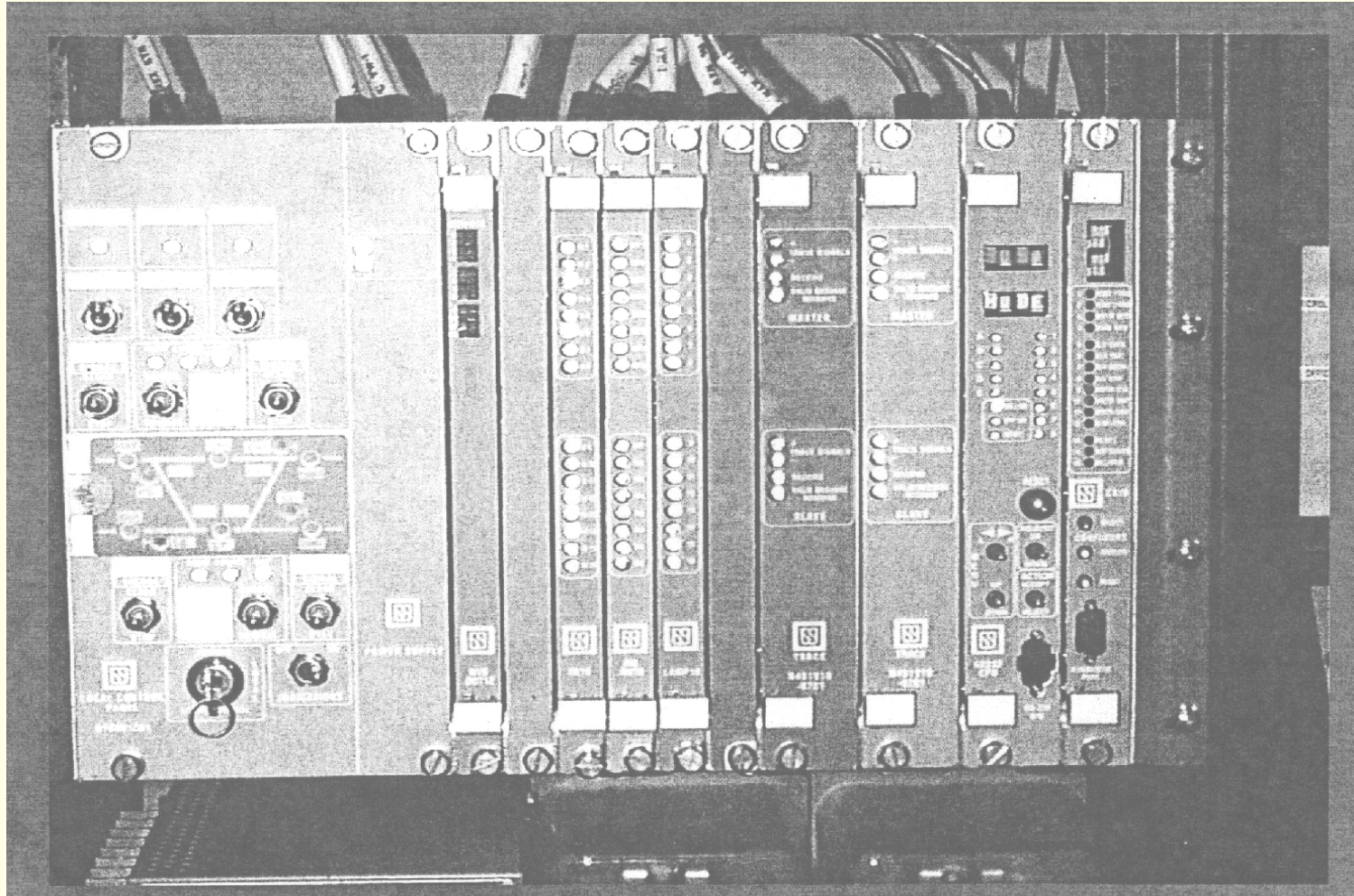
Work Vehicle Segment

- **Contains Roadway Worker Terminal (RWT) which provides communication between a roadway crew EIC and PTC Office Segment to request and display protections and authorities**

- **Uses Commercial-Off-the-Shelf ruggedized Pentium laptop computer and Spec 200 MCP and rail application software**

- **RWT is Integrated with UPRR-furnished hi-rail vehicle**

Work Vehicle Segment

Key RWT Components

- **Control Display Unit (CDU)**
  - Laptop Computer
  - Vehicle Cradle
  - Mount
- **Mobile Communications Package**
  - 900MHz Data Radio
  - Antenna
- **Power Control Panel**

Roadway Worker Terminal Components

- **MCP and Antenna**

- **Laptop Computer**

- **Vehicle Cradle**

Customer Furnished Subsystems

- **Computer-Aided Dispatch:**
  - IDOT PTC System (Office Server) to be integrated with enhanced UPRR CAD II
  - Interface defined among Project Team in accordance with system and design requirements
  - Supports CTC radio-code control of IDOT PTC territory
- **Communications:**
  - ATCS Spec 200 Communications FEP/CC, Antennas/Towers/BCPs

Dispatch Segment (CAD) Overview

- **Overall "C4I" for UPRR Dispatch**

- **Interfaces with LM Office Segment (PTC Office Segment)**

- **Customer (UPRR) Furnished**

- **Located at Harriman Dispatch Center in Omaha, NE**

- **Governs approximately 30,000 track miles across US**

- **Current System is CAD II from Union Switch & Signal - being enhanced to support IDOT PTC requirements**

Communications Segment Overview

- **Basic Functions:**
  - Customer-furnished ATCS Spec 200 X.25 packet switched ground network
  - Interface locally with Dispatch and Office segments located at UPRR Harriman Dispatch Center, Omaha, NE
  - Interface remotely with 10 towers/radio base stations (BCPs) located at different points throughout IDOT PTC territory
  - Provide BCP-MCP communications through radio frequency network to office, locomotives, work vehicles, and field wayside devices

Summary

- **IDOT PTC Project Detailed design well underway:**
  - Key milestone reviews completed:
    - System Requirements Review (SyRR)
    - Software and Hardware Requirements Reviews (SRR/HRR)
    - System and Preliminary Design Reviews (SDR/PDR)
  - Key technical deliverables submitted:
    - Submitted PDR materials and CDR items in process/under review
- **Critical Design Review (CDR) for Build 1 underway**
- **SDI Team looks forward to continued strong progress with IDOT Customer Team to jointly field successful IDOT PTC System**

FRA NGHSR Expectations (Factors for Future Success)

- **Safe high-speed passenger train operation**
- **Use existing tracks**
- **Intermixed freight/passenger operation**
- **Cost effective integrated system**
- **Seamless interoperability among various territories**
  - *Territory change at track speed*
  - *One platform integrated to operate in multi-territories*
- **Minimize unnecessary enforcements due to system problems or hardware failures**
- **Provide tangible benefits besides safety in efficiency and capacity improvements**
- **Highly reliable system that earns trust from operation personnel**